An Assessment of Alaska Cruise Ship Wastewater Discharges

Alan Mearns[1], CJ Beegle-Krause[1], Lincoln Loehr[2], Kenneth Hall[3], Carolyn Morehouse[4], Michael Watson[5], Charles McGee[6] and Kenwyn George[4]

[1]National Oceanic and Atmospheric Administration, [2]Heller Ehrman, White and McAulife, [3]University of British Columbia, [4]Alaska Department of Environmental Conservation, [5]US Environmental Protection Agency X, [6]County Sanitation Districts of Orange County

Keywords: sewage, ships, pollutants, WET, bacteria, dilution

Introduction

Cruise ships represent a 20 billion dollar industry in the US. Vancouver, BC, has been the major departure point for cruise ships to Alaska, but cruise ship departures from Seattle rose from 9 in 1999 to a projected 170 in the 2005 tourist season (May to October; Port of Seattle). This increased activity has caused concern about the fate and effects wastewater discharges and sewage spills in Washington waters. In 2004 the State of Washington and the cruise ship industry signed a Memorandum of Understanding: the industry agreed not to discharge blackwater and greywater in State waters unless they were treated using advanced technologies approved by the US Coast Guard.

In 2001 and 2002 a series of detailed scientific studies were carried out by the State of Alaska and the US Environmental Protection Agency. This paper brings these studies to the attention to the Puget Sound and Georgia Straits community.

Alaska Cruise Ship Initiative and the Science Advisory Panel

The Alaska Cruise Ship Initiative (ACSI) was developed in 2000 to (1) identify waste streams from cruise ships; (2) develop pollution prevention and waste management solutions; (3) assess and verify compliance with volunteer wastewater sampling and; (4) keep the Alaska public informed (Morehouse and Koch 2003). In late 2000 the ACSI commissioned a Science Advisory Panel. Panel members were appointed by the State and the US Coast Guard to answer critical stakeholder questions about the treatment, discharge, dispersion, fate and effects of wastewaters produced by commercial cruise ships. The Panel included scientists from California, Hawaii, Washington, British Columbia and Alaska with expertise in oceanography, bacteriology, chemistry, aquatic and human toxicology, marine biology, ecology and vessel engineering. Institutions represented on the Panel included the US Environmental Protection Agency (Region 10), the National Oceanic and Atmospheric Administration Hazardous Materials Response Division (NOAA HazMat), the State of Alaska, Orange County Sanitation Districts, and the Universities of Alaska, Hawaii, and British Columbia

Over a two-year period Panel members met in Alaska and Seattle and by conference calls. The Panel used a Risk Assessment framework to guide literature reviews, conduct on-board inspections, interview scientists and vendors of advanced wastewater treatment systems, develop and evaluate mixing and dispersion models, recommend effluent bacteriological and chemical sampling, monitoring and toxicity testing methods, and to evaluate monitoring data in the context of dilution modeling, exposure to resources at risk and predicted biological and ecological effects. The Alaska Department of Environmental Conservation, contract laboratories, the industry, and the US Coast Guard carried out sampling and monitoring (Morehouse 2003). During the Panel's most active work (2001 – 2002) cruise ships were implementing a variety of new treatment technologies (Eley and Morehouse 2003), thus giving the panel an opportunity to compare and evaluate their effectiveness.

Results

The Panel's results and recommendations are provided is a series of reports available on the Alaska Department of Environmental Conservation web site (<http://www.state.ak.us/dec/water/cruise_ships/>) and in a series of papers published in the Proceedings of MTS/IEEE Oceans 2003 (see References Cited).

The Panel's Risk Assessment framework started with determining what is in the wastewaters and at what concentrations, then used mixing models to estimate initial ocean water concentrations of fecal bacteria and chemicals and, finally, compared EEC's to existing water quality criteria, guidelines and toxicology literature considering resources at risk on the shoreline, the sea surface, the water column and the sea floor.

Morehouse (2003) reported pH and concentrations of fecal bacteria, nutrients, trace metals and organic chemicals found in over 200 samples of untreated and treated blackwater (sewage) and greywater (laundry and shower wastewater) from several dozen cruise ships sampled in 2000 through 2002. Fecal coliform concentrations varied widely in both grey and blackwater. Of 55 chemicals only 16 occurred above detection limits; PCBs, mercury and cadmium were not detected. Using several simple numerical mixing models, the Panel determined that black and grey wastewater discharging from large cruise ships moving a six knots or greater receive initial dilutions (mixing) in the range of 100,000 to greater than 500,000 to 1 (Loehr et al 2003). Dye dilution studies, conducted off Miami by the US Environmental Protection Agency (Heinen et al 2003), confirmed the high estimated dilutions. To estimate initial ocean water concentrations the Panel chose a conservative mixing rate of 50,000:1. At this dilution, nearly all water quality criteria are met within minutes, regardless of level of treatment; exceptions included several effluents with high fecal coliform and copper. The Panel designed a strategy for both acute and chronic (sublethal) Whole Effluent Toxicity (WET) testing, carried out under the direction of ADEC. The worst-case WET results achieved No Observeable Effects Concentrations (NOECs) at dilutions between between 200 to 1 and 2,000 to 1, with the toxicity being attributed to chlorine (Mearns et al 2003; McGee et al 2003; Loehr et al 2003). The Panel addressed nutrient loading, concluding that the additional phytoplankton production was equivalent to one one-hundredth of the standing crop (Mearns et al 2003). The panel also concluded that the high mixing rate behind a discharging vessel should prevent significant accumulation of contaminants in the sea surface microlayer. Using copper as an example, the Panel calculated that loading from multiple cruise ship tracks in Inside Passage channels would result in surface sediment contamination from 0.8 to 2.9 ppm, well below background concentrations all existing sediment quality guidelines (Mearns et al 2003).

All of these investigations lead the Panel to recommend to ADEC that cruise ships discharge only while underway (>6 knots), at least one mile from shore and avoid stationary discharges and excessive use of chlorine.

The Panel's findings are unique and important because they focus on coastal water quality, not just on effluent quality. We hope interested parties will consult the Panel's findings in future deliberations.

References Cited

Eley, W.D. and C.H. Morehouse 2003. Evaluation of new technology for shipboard wastewater treatment. In: Proceedings, Oceans 2003 Conference, Marine Technology Society, Columbia, Maryland pp748-753.

Heinen, E., K. Potts, L. Snow, W. Trulli and D. Redford. 2003, Dilution of wastewater discharges from moving cruise ships. In: Proceedings, Oceans 2003 Conference, Marine Technology Society, Columbia, Maryland pp386-389.

Loehr, L., M. Atkinson, K. George and CJ Beegle-Krause. 2003. Using a simple dilution model to estimate wastewater contaminant concentrations behind moving cruise ships. In: Proceedings, Oceans 2003 Conference, Marine Technology Society, Columbia, Maryland pp390-393

McGee, C.D., and L.C. Loehr. 2003. An assessment of fecal coliform bacteria in cruise ship wastewater discharge. In: Proceedings, Oceans 2003 Conference, Marine Technology Society, Columbia, Maryland pp733-736.

Mearns, A., M. Stekoll, K. Hall, CJ Beegle-Krause, M. Watson and M. Atkinson. 2003. Biological and ecological effects of wastewater discharges from cruise ships in Alaska. In: Proceedings, Oceans 2003 Conference, Marine Technology Society, Columbia, Maryland pp737-747.

Morehouse, C. and D. Koch. 2003. Alaska's Cruise Ship Initiative and the Commercial Passenger Vessel Environmental Compliance Program. In: Proceedings, Oceans 2003 Conference, Marine Technology Society, Columbia, Maryland pp372-375.

Morehouse, C. 2003. Wastewater sampling and analysis for commercial passenger vessels. In: Proceedings, Oceans 2003 Conference, Marine Technology Society, Columbia, Maryland pp376-385.